Published in final edited form as:
Min Eng. 2013 September ; 65(9): 78–84.

Helmet-Cam: tool for assessing miners' respirable dust exposure

A.B. Cecala, **W.R. Reed**, **G.J. Joy**, **S.C. Westmoreland**, and **A.D. O'Brien**
A.B. Cecala, W.R. Reed and G.J. Joy, members SME, are mining engineers and industrial hygienist at the National Institute for Occupational Safety and Health (NIOSH), Pittsburgh, PA. S.C. Westmoreland is regional general manager at Unimin Corp., Gore, VA and A.D. O'Brien is vice president Safety and Health at Unimin Corp., Winchester, VA

Abstract

Video technology coupled with datalogging exposure monitors have been used to evaluate worker exposure to different types of contaminants. However, previous application of this technology used a stationary video camera to record the worker's activity while the worker wore some type of contaminant monitor. These techniques are not applicable to mobile workers in the mining industry because of their need to move around the operation while performing their duties. The Helmet-Cam is a recently developed exposure assessment tool that integrates a person-wearable video recorder with a datalogging dust monitor. These are worn by the miner in a backpack, safety belt or safety vest to identify areas or job tasks of elevated exposure. After a miner performs his or her job while wearing the unit, the video and dust exposure data files are downloaded to a computer and then merged together through a NIOSH-developed computer software program called Enhanced Video Analysis of Dust Exposure (EVADE). By providing synchronized playback of the merged video footage and dust exposure data, the EVADE software allows for the assessment and identification of key work areas and processes, as well as work tasks that significantly impact a worker's personal respirable dust exposure. The Helmet-Cam technology has been tested at a number of metal/nonmetal mining operations and has proven to be a valuable assessment tool. Mining companies wishing to use this technique can purchase a commercially available video camera and an instantaneous dust monitor to obtain the necessary data, and the NIOSH-developed EVADE software will be available for download at no cost on the NIOSH website.

Introduction

In the metal/nonmetal mining industry, mobile workers have some of the highest overexposure rates for silica and other respirable dust. Table 1 lists the overexposure rates of a few mobile worker job categories for a 15-year time period (1995–2009) based upon U.S. Mine Safety and Health Administration (MSHA) respirable dust compliance sampling results. When one considers this data, a difficult challenge is trying to determine what tasks

Disclosure
The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health. Mention of any company or product does not constitute endorsement by NIOSH.

or processes have the greatest impact on these workers' exposure. For this article, the term "mobile worker" includes all workers in the various MSHA occupational codes listed in Table 1 and represents workers who typically move to various locations throughout a mining facility to perform their job duties and functions. Over the years, video technology has been used to evaluate worker exposure to different types of contaminants. These studies have used a stationary video camera to record exposure while the worker wore some type of contaminant monitor (Gressel et al., 1988; Gressel et al., 1992; Rosen and Lundstrom, 1987; Rosen and Andersson, 1989; Rosen et al., 2005, McGlothlin, 2009). Unfortunately, these techniques are not applicable for mobile workers in the mining industry because of their need to move to various locations throughout the mining operation to perform their duties. The newly developed Helmet-Cam technology provides a video display of the work or task performed by a worker along with the worker's respirable dust exposure providing insight into work areas and tasks that cause a miner to have elevated respirable dust exposures.

The Helmet-Cam technology was developed under a cooperative relationship between Unimin Corp. and the U.S. National Institute for Occupational Safety and Health (NIOSH). Andrew O'Brien and Steve Westmoreland, with Unimin, originally discussed the possibility of combining a small video camera with an instantaneous dust monitor to determine a worker's respirable dust exposure without the need for another worker to actually observe the miner being monitored. At this point, Unimin approached NIOSH researchers and asked if they would consider working jointly on this project. Because this effort supported the NIOSH mission to reduce silicosis/pneumoconiosis among miners, and because NIOSH was interested in lowering the respirable dust exposure of mobile workers, they agreed to partner with Unimin on this research effort, which was named Helmet-Cam.

The Enhanced Video Analysis of Dust Exposure (EVADE) software was developed by the NIOSH Office of Mine Safety and Health Research Computational Research Team in Pittsburgh. It merges the video and dust data, gathered by a small video camera and an instantaneous dust monitor, together into a user-friendly format. Initially, the Helmet-Cam testing was performed at a silica sand processing facility. Through this testing, a number of modifications were incorporated into the original layout of the EVADE viewing screen, as well as a number of functions that were improved within the program. In addition to the software modifications, this initial field testing also provided insight into other means to allow the miners to comfortably wear the dust monitor and video component of the Helmet-Cam technology while performing their work in an uninhibited manner.

After the initial testing, a number of other industrial minerals companies operating surface mining and/or processing facilities participated with NIOSH in field testing this new technology. Recently, the Helmet-Cam technology was also tested at an underground limestone mine. This testing and the input of the many participating mining partners have resulted in further improvements to the EVADE software package and the deployment of the video recorder and exposure monitor. This Helmet-Cam technology and the EVADE assessment software are now ready to be used by any mining operation or by other industries wanting to assess their workers' respirable dust exposure.

Helmet-Cam equipment and testing procedures

Helmet-Cam is a simple and relatively inexpensive technology to set up and use. It consists of a lightweight video camera, an instantaneous dust monitor and a method for housing these two instruments in a way that allows miners to perform their work in a normal and unimpeded fashion. Once the video footage and dust data are obtained, the information is downloaded to a computer and the EVADE software merges the footage and dust data to assess the areas, tasks, and functions that impact the miner's respirable dust exposure. There are a number of different types of commercially available cameras and dust monitors that can be used, although the authors will only discuss the actual units used by NIOSH during testing of this new technology.

The first component that a company needs to obtain is a small compact video camera used to record the worker's location and the tasks and functions being performed over time while wearing the Helmet-Cam unit. The initial video unit chosen and tested by NIOSH was the POV (point-of-view) camera. This system employs a video lens attached to the miner's hardhat using a commercially available flashlight clip. A thin cable approximately 45.7 cm (18 in.) in length connects the video lens to the digital video recording portion of the device. This video device creates two digital video files, an "avi" and a "thm" extension, respectively, which are then used by the EVADE software program.

The second component of the system is the instantaneous dust monitor. NIOSH chose the Thermo Scientific pDR-1500 instantaneous monitor for the Helmet-Cam testing. Because this instrument was relatively new, NIOSH performed a comprehensive laboratory study at its Pittsburgh location to ensure that the unit provided comparable dust data to what would be obtained with MSHA compliance and in-house gravimetric dust sampling (Reed et al., 2012). This instrument was attractive to NIOSH researchers because it is an active sampler using an internal pump to collect the sample. This unit was slightly modified so that a 0.91-m (3-ft) section of conductive tubing could be used to connect to the 10-mm Dorr-Oliver cyclone, which is the normal pre-classifier device used for respirable dust sampling in the metal/nonmetal mining industry. The pDR-1500 was also set to a 1.7-L/min flow rate, which is the required flow rate as established by the American Conference of Governmental Industrial Hygienists (ACGIH) for the metal/nonmetal industry (MSHA, 1990).

To begin testing, the 10-mm cyclone was placed on the miner's lapel, within the miner's breathing zone and similar to the method used for a compliance-type dust sample. A 0.91-m (3-ft) length of conductive tubing was used to connect the 10-mm cyclone to the main body of the pDR-1500 monitor. This length of tubing allowed the worker to perform their job function without interference. The dust monitor was configured to integrate samples over a two-second time period for this testing, which provided fast dust concentration changes to correspond with the video component. The miner was then asked to perform his or her normal job duties for a pre-determined time period; afterwards the video and respirable dust exposure data files were downloaded using the instrument's output functions. Figure 1 shows the components of the Helmet-Cam system.

The last item necessary for the Helmet-Cam unit is some type of method to house the video camera and dust monitor on the miner to allow him or her to work with minimal interference. The miners were offered a number of different options to house the instruments. The first option was a lightweight backpack with a number of pockets to house the camera's logger unit and the dust monitor. An advantage with this backpack was that it had two straps, one at chest level and the second at the waist, which allowed the backpack to be securely tightened to the wearer. This was especially beneficial for active workers, such as a bulk-loading operator. Another option was two different styles of miner's belts with shoulder straps. This allowed the video datalogger and instantaneous dust monitor to be strapped onto the sides of the belt. The shoulder straps minimized the weight of the instruments being on the worker's waist and also allowed the 10-mm Dorr-Oliver cyclone to be connected in a location within an acceptable range of the worker's breathing zone. Once the cyclone was attached with duct tape to the shoulder strap, a three-foot section of conductive tubing was then used to attach the cyclone device to the pDR-1500 dust monitor.

Figure 2 shows applications with a backpack, two types of miners' safety belts and a safety vest. Once that selection was made, the video camera datalogger, dust monitor and the 10-mm Dorr-Oliver cyclone were attached to the housing setup method. The video camera lens was attached to the worker's hardhat using a holder for a small flashlight. The video unit was turned on and the lens was adjusted to ensure that it was recording in a horizontally aligned manner. The camera lens was attached to the worker's hardhat and duct-taped in place to ensure that the camera lens did not move over time and lose its alignment as workers performed their job tasks. Next, video cable and the tubing for the dust monitor were secured to minimize the possibility of their being caught or tangled during use in the workplace. At this point, the video camera and dust monitors were started simultaneously. It was critical that both units were started at the same time, because there is no current adjustment in the EVADE software to offset the start time.

The miner was asked to return to work and to wear the Helmet-Cam system for a predetermined time frame. For NIOSH's testing, this time frame varied somewhere between two and four hours. The miner was instructed to perform his or her routine duties without any changes or deviations due to wearing the device. For all testing, the video sound function was deactivated.

Once the miner returned from working, both the dust monitor and video camera were downloaded to a laptop computer. Because numerous workers were to be evaluated at the same site, it was important to differentiate the numerous video and dust data files taken at an operation. Normally, a folder was created for the mine for each day of testing and the video and dust files were renamed to the worker's job name or job task after being downloaded. When using the EVADE software, this naming system was used to ensure that the correct video and dust files were linked together in the analysis software program.

Discussion of field testing results

The initial field test on the Helmet-Cam was performed at a mineral processing facility during a rainy two-day time period; therefore, it was not representative of respirable dust levels during normal (dry) mining conditions at this operation. Although the respirable dust levels were very low, this testing was beneficial to determine all aspects and logistics of the entire Helmet-Cam field testing cycle, which included preparing the equipment for testing, having miners come to a predetermined area to get them set up with the Helmet-Cam system, downloading the data once the worker completed testing for the allocated time period, and preparing the instruments for use by the next miner.

One issue that came to light during this initial field test was the discomfort caused by the safety vest used to hold the package. This was especially true for a bulk-loading operator who was required to wear a fall-protection harness that had the connecting point at the front of the wearer. Another issue was the tremendous size of the video files, which overwhelmed the storage capacity of the laptop computer in this testing. This problem was solved by purchasing portable external drives and downloading the files onto portable units.

To address the issue of safety vest comfort, a brainstorming session was performed with mine management and the miners who wore the Helmet-Cam device. Based on these discussions, a compact backpack was chosen that housed both instruments in compartments and allowed for the wire and tubing to be neatly stored. In addition, two types of miner's belts were purchased in multiple sizes. Both type of belts had shoulder straps that distributed the weight and were comfortable for the miners. With these new belts, the dust monitor and datalogger unit for the video camera could be placed in various positions based upon the wearer's wishes and comfort. For workers who needed to sit while performing their jobs, as in the case for equipment operators, the instruments were positioned on either side of the waist. This allowed them to sit comfortably as well as to get up and move around to perform other duties.

After these issues were resolved, a number of additional field studies were performed to evaluate the effectiveness of the Helmet-Cam technology as a method of determining elevated respirable dust exposures for miners. A typical Helmet-Cam trial was two consecutive days in length, with each day broken up into segments. Ideally, three to four workers were asked to wear the Helmet-Cam for two to four hours. Then, the information was downloaded and a different group of three to four workers were asked to wear the Helmet-Cam for the second half of the shift. Workers were also monitored on the second and third shift if applicable.

Worker participation in the NIOSH testing was voluntary and more than 100 different individuals have worn the Helmet-Cam unit. From these evaluations, only one worker terminated the testing early for personal reasons. In a number of cases, after a worker was allowed to view the EVADE software footage of the video and respirable dust data merged together, the worker asked to wear the unit again on the second day of testing in order to perform other duties not performed on the first day.

Case study results

Based on the numerous field tests, the following are a few examples showing the ability of the Helmet-Cam method to identify high exposure areas, functions and/or job tasks.

Automated device to remove wet sand when screening process is started—When production is restarted after being off for an extended period of time, it is common to encounter wet product material in a number of locations throughout a processing operation. Wet product material is not a problem in many work locations, but it is for the screening process. If this wet product travels to the screening area, it causes the screens to clog or glaze over, which is a maintenance and productivity problem. This operation's method to address this issue was to have a process helper manually place a scraper device on the product feed conveyor belt to divert the wet product away from the screening area until the product was dry.

In the case described above, it was determined from the Helmet-Cam technology that the process helper's respirable dust exposure was greatly elevated while performing this task (see Fig. 3). In order to eliminate this exposure, the operation installed an automated system that allowed the process operator to visually determine in the control room the product moisture content on the conveyor line, allowing this worker to engage a control switch to mechanically divert this product away from the screening process until the wet product had passed. When the product moisture monitor showed acceptable levels, the process operator deactivated the switch and the mechanical diverter was retracted, allowing the product to again flow to the screening area. Through the Helmet-Cam technology, the worker's elevated exposure during this task was determined, allowing for a modification to the system to automate the process and eliminate the worker's respirable dust exposure while manually performing this task.

Cleanliness of lunch room/break area—It was observed that when a Helmet-Cam participant went into the lunch room/break area, the worker removed the Helmet-Cam unit and placed it on a cloth chair. As other workers came into the area and sat in other cloth chairs, the levels recorded on the Helmet-Cam device were higher for this 30-minute period than for any other time when the worker was wearing the device. When this operation considered the number of cloth chairs in the area and the dust liberation potential that could occur as workers sat and moved around in each of these chairs, the magnitude of this dust source was realized. It was also determined that housekeeping in this lunch room/break area was not up to standard with other areas of the facility, with respirable dust being liberated as individuals moved around the room. This result was surprising because one would expect this area to be one of the least dusty areas encountered in a miner's workday. After learning this information from the Helmet-Cam technology, this operation disposed of all the cloth chairs in the lunch room/break area and purchased new molded plastic chairs. These new chairs are much easier to clean and do not retain dust like cloth chairs. In addition to this, housekeeping and cleanliness in this area was improved and it became a priority to keep this area clean.

Minimizing dust exposure while emptying hopper—When an operation completed bagging one particular size of product material at its flexible intermediate bulk container (FIBC) bagging facility and there was still excess product in the fill hopper, a worker would dump this excess product into a dumpster and dispose of it. This dumping process was repeated multiple times until the bin was completely emptied. This task was performed by using a forklift to position a dumpster on the floor directly under the FIBC loading spout. The FIBC loading operator would then manually engage a mechanical arm, which allowed the product to flow into the dumpster. The loading operator was positioned within a meter from the dumpster and about 1.2–1.5 m (4–5 ft) away from the loading spout during this task. It was believed that if the dumping distance was minimized, this would also lower the operator's respirable dust exposure. To test this theory, both techniques were tried while the loading operator was wearing the Helmet-Cam device. Five different trials were performed with the typical technique of placing the hopper on the ground, followed by seven trials with the modified design of having the dumpster raised, all using the same product material. Each of these trials ranged somewhere between 30 seconds to one minute. In the modified version, the dumpster was raised to the highest level under the loading spout while still allowing the operator to maintain visibility of the level of loading (Fig. 4). The loading operator's respirable dust exposure was 1,160.3 $\mu g/m^3$ with the hopper on the ground, compared to 240.4 $\mu g/m^3$ with the dumpster in the modified/raised position. The Helmet-Cam system allowed for a quick and effective comparison of these two dumpster positions, and indicated an approximate 80% reduction in the operator's exposure through the use of this simple task modification.

Using the EVADE software

This section will briefly mention a few basic features of the EVADE software that are beneficial when evaluating Helmet-Cam results. First, it is important to stress that the video file (avi) and the corresponding dust data file (csv) must be located in the same folder for the EVADE software to successfully merge these files and operate the program.

Once the EVADE software is opened and the corresponding video and dust files are chosen, the user's screen appears with the video shown in the top right and the dust exposure data along the bottom of the screen (Fig. 5). When the user activates the "Start" button, the video plays in real time as the dust data scrolls across the bottom of the screen. In the graph, a vertical green bar is visible in the center of the screen showing the exact dust data point that corresponds with the video data being shown. For NIOSH testing, the dust monitor was set to take a respirable dust reading every two seconds. This two-second reading can be seen in the graph in Figs. 3 and 5, which is located immediately above the graph as a numerical value, preceded by the word "Reading." This value then changes every two seconds. The graph and the visual dust data concentration reading can be easily switched back and forth within the program from milligrams per cubic meter to micrograms per cubic meter.

A feature of the EVADE software is the zoom function located midlevel on the left side of the screen. By sliding this zoom function bar in one direction or the other, it allows the dust data to be quickly compressed or expanded. When the bar is slid to the left, the dust data is expanded and, at a certain point, the individual two-second dust data points are actually visible on the dust graph and shown as blue dots. When the bar is slid to the right, the dust data is condensed, allowing the user to more easily observe trends in the worker's dust exposure. When the zoom bar is all the way to the left, the full-screen dust data only spans a few seconds compared to when it is all the way to the right, where the full screen dust data represents approximately 90 minutes. This gives the viewer a wide spectrum for the level of detail when viewing the dust data.

Another option in the software is the ability to automatically or manually scale the dust data in the graph based on the user's preference. In the manual mode, the user sets the upper limit for the graph, even if data points exceed this maximum value. Another feature is the ability to set threshold values on the graph. The user can add one or more threshold value lines on the graph and provide a name for each of these values. The user then chooses from over 140 different color options and six different line styles when creating a threshold value line.

To allow easy retrievable access to the highest exposure data, the EVADE software program automatically creates bookmarks for the five highest dust concentration peaks. When users choose the bookmark function, they will see that bookmarks entitled "MAX1" through "MAX5" have already been created. The "MAX1" corresponds to the highest spiked values recorded in the data and then continues to the fifth highest values, called "MAX5." If the user selects one of these MAX values, the program will immediately advance to that point in the video and dust data where that value occurs.

If users would like to create and name their own bookmarks, this is easily done within the EVADE program. When the bookmark function is activated, one critical aspect is that the user needs to be at the exact location in the video and dust data where the bookmark will be listed. When a bookmark is created, the program will return to this exact spot each time the bookmark is selected. Bookmarks are beneficial for safety meetings and other presentations, allowing the presenter to quickly advance to segments of the video and dust data to show elevated exposures.

Another method used to advance through the EVADE footage is the "scroll" option and "drag" function, which provide the ability to quickly move through the data without the need to advance in real time. The scroll option, located immediately above the dust graph, gives the user the ability to scroll toward the beginning or end of the dust and video data. The other method for doing this is the "drag" function, where the user places the mouse over the dust data graph and left-clicks. Then, if the user moves the mouse to the right or left, the program quickly advances through the dust data and video until the user stops.

A final noteworthy feature of the EVADE software is the use of screenshots. Screenshots are jpg files that provide a "snapshot" of exactly what the EVADE screen is showing when the screenshot is created. These screenshots are beneficial for safety meetings and other presentations. These files can also be inserted easily into Word documents and PowerPoint presentations, and were used to create the various EVADE figures in this document.

Conclusions

Despite developments in technology, the ability to determine a mobile miner's exposure to various types of contaminants has not advanced much during the past few decades. With mobile workers performing many different types of tasks and functions in many different locations throughout the workday, it is difficult and resource-intensive to determine where a worker is being exposed to respirable dust through traditional time study methods. The

Helmet-Cam technology has proven to be a viable tool to provide this assessment and determine where and when a mobile mine worker is being exposed to respirable dust. Although this assessment tool was originally developed for respirable dust, it is in the process of being expanded to assess other contaminants, and is currently being investigated by NIOSH for diesel (elemental carbon) and noise exposure. It is envisioned that future versions of the EVADE software may be able to simultaneously evaluate exposures to multiple contaminants using the same video footage. The Helmet-Cam technology is currently available for the assessment of worker's respirable dust exposure in mining. All that an interested mining operation has to do is purchase a video camera and an instantaneous dust monitor to begin the process. The EVADE software will be available by the end of 2013 at the NIOSH Office of Mine Safety and Health Research website at http://www.cdc.gov/niosh/mining/features/helmetvideoidentifieshighdustexposure.html. Until the software is available, interested parties can contact the authors for assistance.

Acknowledgments

The authors thank Augie Kwitowski and William Helfrich, with NIOSH's Division of Mining Science and Technology (DMST), Health Communications, Surveillance and Research Support Branch (HCSRSB), Computational Research Team in Pittsburgh, for developing the EVADE software program.

They also thank the following companies and their sites for participating in this study: Unimin Corp.: Gore Facility, Gore, VA; Kasota Facility, Mankato, MN. U.S. Silica Co.: Berkeley Springs Facility, Berkeley Springs, WV; Mapleton Depot Facility, Mapleton Depot, PA; Mauricetown Facility, Mauricetown, NJ. Badger Mining Co.: Taylor Facility, Taylor, WI; Fairwater Facility, Fairwater, WI. 3M: Greystone Facility, Wausau, WI. Sidwell Corp.: Zanesville Mine, Zanesville, OH. The authors thank these operations and the men and women at these facilities who participated in this new dust assessment study.

References

Gressel MG, Heitbrink WA, McGlothlin JD, Fischbach TJ. Advantages of real-time data acquisition for exposure assessment. Applied Industrial Hygiene. 1988; 3(11):316–320.

Gressel, MG.; Heitbrink, WA.; Jensen, PA.; Cooper, TC.; O'Brien, DM.; McGlothlin, JD.; Fischbach, TJ.; Topmiller, JL. Analyzing Workplace Exposures Using Direct Reading Instruments and Video Exposure Monitoring Techniques. Gressel; Heitbrink, editors. 1992. DHHS (NIOSH) Publication Number 92–104

McGlothlin JD. Video exposure monitoring: The wow factor. The Synergist. 2009; 20(9):35–37.

MSHA. Mine Safety and Health Administration Metal, Nonmetal Health Procedures Manual (PH90-IV4). Arlington, VA: 1990. Chapter D

Reed, WR.; Potts, JD.; Cecala, AB.; Archer, WJ. Use of the pDR-1500 for gravimetric respirable dust measurements at mines. Preprint #: 12-001. 2012 SME Annual Meeting & Exhibit; Feb. 19–22, 2012; Seattle, WA. 2012.

Rosen G, Lundstrom S. Concurrent video filming and measuring for visualization of exposure. Am Ind Hyg Assoc. 1987; (48):688–692.

Rosen G, Andersson I. Video filming and pollution measurement as a teaching aid in reducing exposure to airborne pollutants. Ann Occup Hyg. 1989; 33(1):187–144.

Rosen G, Andersson I, Walsh PT, Clark RDR, Saamanen A, Heinonen K, Riipinen H, Paakkonen R. A review of video exposure monitoring as an occupational hygiene tool. Ann Occup Hyg. 2005; 49(3): 201–217. [PubMed: 15701684]

Figure 1.
Helmet-Cam setup showing video camera lens on a miner’s hardhat, the digital video recording portion of the video camera and pDR-1500 dust monitor, and the 10-mm cyclone.

Figure 2.
Various options to house the Helmet-Cam system: backpack, two types of miners' safety belts and safety vest.

Figure 3.

Screenshot of miner using manual scraper to bypass the screening process until product was dry.

Figure 4.
FIBC loading operator performing a load-out task with dumpster on floor (L) and a modified setup with dumpster raised (R).

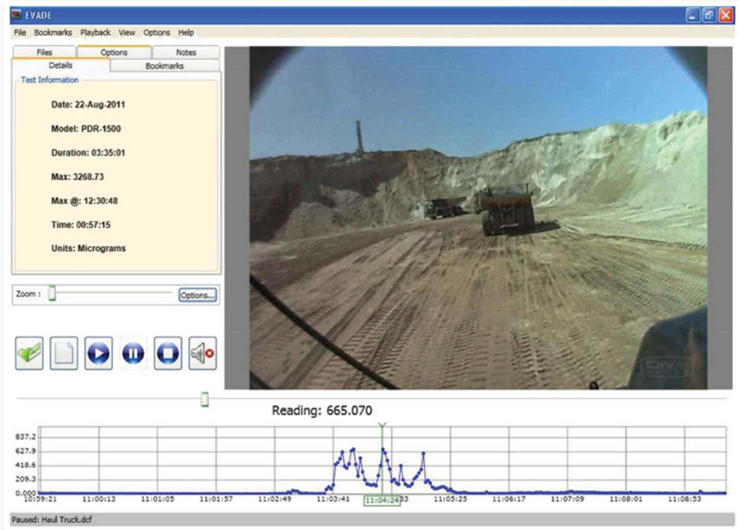

Figure 5.

Screenshot of EVADE user's screen. The video is in the top right corner and the respirable dust control graph appears along the bottom of the screen. Each blue dot on the graph represents a two-second respirable dust measurement. This Helmet-Cam unit was inside the enclosed cab of a haul truck.

Table 1

Overexposure rates for metal/nonmetal industry based on MSHA data from 1995 to 2009.

	Sand and gravel		Stone quarries		Metal mining	
Occupation	**No. samples > PEL**	**Total samples**	**No. samples > PEL**	**Total samples**	**No. samples > PEL**	**Total samples**
Laborer	202 (20%)	1,032	176 (14%)	1,276	20 (37%)	54
Mechanic	17 (11%)	149	13 (8%)	160	10 (21%)	48
Utility man	24 (9%)	272	98 (13%)	766	8 (47%)	17
Cleanup man	117 (23%)	518	82 (17%)	476	13 (38%)	34